7.1 Exponent Rules

Student Text Pages
356–363

Suggested Timing
80 min

Tools
• calculators

Related Resources
BLM 7-3 Section 7.1 Exponent Rules

Link to Prerequisite Skills

In this section, students apply skills related to positive, integral exponents and they use formulas to calculate a variety of measures. Students should complete Prerequisite Skills questions 1, 2, and 6 before proceeding with this section.

Warm-Up

1. Write as a power.

a) $5 \times 5 \times 5$

b) 7×7

c) $9 \times 9 \times 9 \times 9 \times 9$

d) $(-6)(-6)(-6)(-6)$

2. Evaluate each power mentally.

a) 3^2 **b)** 7^2 **c)** 2^3 **d)** 5^3 **e)** 3^4

f) 2^6 **g)** 5^4 **h)** 10^5 **i)** $(-2)^2$ **j)** $(-2)^3$

Warm-Up Answers

1. a) 5^3 **b)** 7^2 **c)** 9^5 **d)** $(-6)^4$

2. a) 9 **b)** 49 **c)** 8 **d)** 125 **e)** 81

f) 64 **g)** 625 **h)** 100 000 **i)** 4 **j)** –8

Teaching Suggestions

Warm-Up

- Write the Warm-Up questions on the board or on an overhead. Have students complete the questions independently. Then, discuss the solutions as a class.

Section Opener

Investigate

- Have students work in pairs to complete the Investigate. This allows them to discuss their results. Have students reproduce the tables in their notebooks. Make sure they reflect on each part before moving on to the next table.
- Ask students to describe their rules and write them on the board for class discussion.

Investigate Answers (pages 356–357)

1. a)

Poduct	Expanded Form	Number of Factors	Single Power
$5^2 \times 5^4$	$(5 \times 5) \times (5 \times 5 \times 5 \times 5)$	6	5^6
$3^5 \times 3^2$	$(3 \times 3 \times 3 \times 3 \times 3) \times (3 \times 3)$	7	3^7
$(-2)^5 \times (-2)^2$	$[(-2) \times (-2) \times (-2) \times (-2) \times (-2)] \times [(-2) \times (-2)]$	7	$(-2)^7$
$(-3)^4 \times (-3)^3$	$[(-3) \times (-3) \times (-3) \times (-3)] \times [(-3) \times (-3) \times (-3)]$	7	$(-3)^7$
$\left(\frac{1}{2}\right)^3 \times \left(\frac{1}{2}\right)$	$\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$	4	$\left(\frac{1}{2}\right)^4$

b) $a^m \times a^n = a^{(m+n)}$

2. a)

Quotient	Expanded Form	Number of Factors Remaining	Single Power
$\frac{5^6}{5^2}$	$\frac{5 \times 5 \times 5 \times 5 \times \cancel{5 \times 5}}{\cancel{5 \times 5}}$	4	5^4
$\frac{3^5}{3^2}$	$\frac{3 \times 3 \times \cancel{3 \times 3 \times 3}}{\cancel{3 \times 3 \times 3}}$	3	3^2
$\frac{(-7)^3}{(-7)^2}$	$\frac{(-7) \times \cancel{(-7) \times (-7)}}{\cancel{(-7) \times (-7)}}$	1	-7
$4^7 \div 4^4$	$\frac{4 \times 4 \times 4 \times \cancel{4 \times 4 \times 4 \times 4}}{\cancel{4 \times 4 \times 4 \times 4}}$	3	4^3
$\left(\frac{2}{3}\right)^4 \div \left(\frac{2}{3}\right)^3$	$\frac{\left(\frac{2}{3}\right) \times \cancel{\left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right)}}{\cancel{\left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right)}}$	1	$\frac{2}{3}$

b) $a^m \div a^n = a^{(m-n)}$

3. a)

Power of a Power	Expanded Form	Number of Factors	Single Power
$(5^3)^2$	$(5 \times 5 \times 5) \times (5 \times 5 \times 5)$	6	5^6
$(3^2)^4$	$(3 \times 3) \times (3 \times 3) \times (3 \times 3) \times (3 \times 3)$	8	3^3
$(2^2)^3$	$(2 \times 2) \times (2 \times 2) \times (2 \times 2)$	6	2^6
$(6^5)^2$	$(6 \times 6 \times 6 \times 6 \times 6) \times (6 \times 6 \times 6 \times 6 \times 6)$	10	6^{10}
$(4^3)^3$	$(4 \times 4 \times 4) \times (4 \times 4 \times 4) \times (4 \times 4 \times 4)$	9	4^9

b) $(a^m)^n = a^{mn}$

4. a) 6^5 **b)** 5^6 **c)** 10 **d)** 7^4 **e)** 10^8 **f)** 5^4

Examples

- Have students work through the Examples as a class before proceeding to the Discuss the Concepts. Alternatively, have students complete the Examples independently or in small groups before reviewing them as a class.
- For Example 1, work through numerous examples of the use of the exponent rules. Showing both methods confirms their equivalence. Ask students which method they find quicker or easier and have them explain why.
- Contextual examples, such as Example 2, are important to show students the importance of learning these skills. This Example refers to earthquake intensity, with the Richter scale as the exponent on base 10. Discuss the rapid growth in intensity as you make your way up the Richter scale.
- Refer students to the Math Connect. Students may not understand the term, "tidal effects". Explain that these are gravitational forces exerted on the moon, from the Earth and the sun.

Key Concepts

- Discuss the Key Concepts as a class. You may wish to have students make up their own examples for each concept.

Discuss the Concepts

- Have the students work with a partner to answer these questions. Discuss the answers as a class before moving on to the exercises.

Discuss the Concepts Suggested Answers (page 360)

D1. As the magnitude increases by 1, the intensity increases by a factor of 10.

D2.
$$\left(\frac{1}{81}\right)^3 = \left(\frac{1}{3^4}\right)^3$$
$$= \left(\frac{1}{3}\right)^{12}$$
$$= \left(\frac{1}{3^2}\right)^6$$
$$= \left(\frac{1}{9}\right)^6$$

So, $\left(\frac{1}{81}\right)^3 = \left(\frac{1}{9}\right)^6$

D3. Maggie's solution is not correct. She multiplied the exponents, but when you find the product of two powers, you add the exponents.

$2^2 \times 2^3 = 2^{2+3}$
$= 2^5$

Practise (A)

- Encourage students to refer to the Examples before asking for assistance.
- **Questions 1 to 5** provided essential practice in working with the exponent rules. You may wish to add a few questions such as $4^5 \times 3^2$, where the exponent rules do not apply, or more practice of the skills, such as those in **questions 2 and 3**.
- **Questions 6 to 8** provide interesting comparisons of various earthquakes in Canada and around the world.

Apply (B)

- **Question 9** is a Literacy Connect. You may wish to assign this question as a journal entry or to discuss the question as a class. Literacy Connect questions offer the opportunity to explore literacy issues in the mathematics classroom and within the context of mathematics.
- **Questions 9 and 10** encourage students to think about exponents in different ways.
- **Questions 11 to 15** are good contextual problems that require the use of the exponent rules.
- **Question 12** provides a good connection to the Imperial system, where fractions are more prevalent.
- **Question 15** refers to the formula for the volume of a cube, which is also used in **question 14**.

Common Errors

- Some students may combine the bases when applying the product and quotient rules to evaluate expressions involving exponents. For example, they may think $3^2 \times 3^4 = 9^6$.

R_x Have students expand each power and count the number of factors. So, the product $3^2 \times 3^4$ is 3^6.

Accommodations

Visual—provide enlarged photocopies of the tables for the Investigate

Language—ask students to state the exponent rules verbally

Motor—reduce the number of practice problems and provide help with scribing during class time

Memory—place posters with the exponent rules on the classroom walls to help students remember them

Gifted and Enrichment—have students make up problems similar to the one in Discuss the Concepts question D2 and challenge each other to solve them

Extend (C)

- Assign the Extend questions to students who are not being challenged by the questions in Apply.
- **Questions 16 and 17** provide a challenge to motivated students. These questions are accessible to students working at levels 3 or 4.
- As a challenge, give your students this power to evaluate:

$$\left(\left(\left(\left(\left(2^2\right)^2\right)^2\right)^2\right)^2\right)^2$$

Answer: $2^{128} \doteq 3.4028 \times 10^{38}$

Mathematical Process Expectations

Process Expectation	Questions
Problem Solving	6–8, 11, 15
Reasoning and Proving	9, 10, 13
Reflecting	n/a
Selecting Tools and Computational Strategies	1–8, 11–17
Connecting	9, 10, 14, 15
Representing	9, 10
Communicating	9, 10

Ongoing Assessment

- While students are working, circulate and see how well each works. This may be an opportunity to continue observing and recording individual students' learning skills.

Extra Practice

- You may wish to use **BLM 7-3 Section 7.1 Exponent Rules** for remediation or extra practice.